Supporting Information

Highly sensitive piezotronic pressure sensors based on undoped GaAs nanowire ensembles

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S1. Experimental: NW growth and device processing

Four inch <111> p-doped Si wafers with a resistivity of < 0.03 Ω·cm (doping 10^{18}cm^{-3}) were diced into 35 × 35 mm^2 square chips to fit in the MBE sample holder. The chips were initially immersed in a buffered HF solution (7:1) for 5 min to remove the native oxide, and subsequently grow a thin oxide (~1.1 nm) layer using 200 W, 200 sccm O_2 plasma power in TEPLA^{TM} GigaBatch for 30 seconds. The final oxide thickness was monitored with a Sopra GES 5E spectroscopic ellipsometer. The prepared chips were introduced into the ultra-high vacuum (UHV) environment MBE machine (DCA P600) and subsequently annealed at 500 °C for 2 hours in UHV to ensure a pristine surface free of water and organic molecules. The chips were then transferred to the growth chamber where they were de-gassed at 770 °C for 30 min to further remove any possible surface contaminants. In the first step, Ga was pre-deposited for 10 min at beam equivalent pressure (BEP) of 1.4×10^{-7} Torr (corresponding to a nominal deposition rate of 1.1 Å/s) by keeping the shutter open. Once growth temperature had been reached, the As_4 source was opened for 20 min at BEP of 2×10^{-6} Torr, at a substrate temperature of 634 °C measured by a pyrometer, and with 7 rpm rotation. No dopants were introduced and hence the NWs were nominally undoped. This process resulted in the growth of island-like clusters, zinc-blende NWs with generally thin and long morphology, and wurtzite NWs.

Two layers of polyimide (Sigma Aldrich, 12.8 wt.%, 80% NMP/20% aromatic hydrocarbon, then mixed 1:1 with NMP) were spin coated on to the ensemble to fully embed the nanowires (1500 RPM for 15s followed by 2500RPM for 1min; 500RPM for 15s followed by 1500 RPM for 1min), and the sample was then placed in an oven at 150°C for 2 hours. Next, the polyimide was etched by oxygen plasma in order to expose the tips of the NWs. The sample was then etched using HCl (20%) for 25s, rinsed in DI water and dried using nitrogen gun, and subsequently sputtered with gold (Emitech) via a shadow mask, in order to create multiple top-electrodes, with the substrate serving as the common bottom electrode. Each device was electrically contacted with a thin copper wire attached to the top electrode using silver paint, while the bottom electrode was connected to a conductive substrate via a silver paint for electrical access. The entire sample was then encapsulated by polydimethylsiloxane (PDMS), using multiple coating stages (spin and bake) to ensure good and stable coverage.

For a band diagram simulation, one dimensional Schrödinger–Poisson equation is solved self-consistently using Nextnano software package [1]. We considered rear contact as ohmic. In case of front contact, fermi level pinning and Schottky barrier are considered.

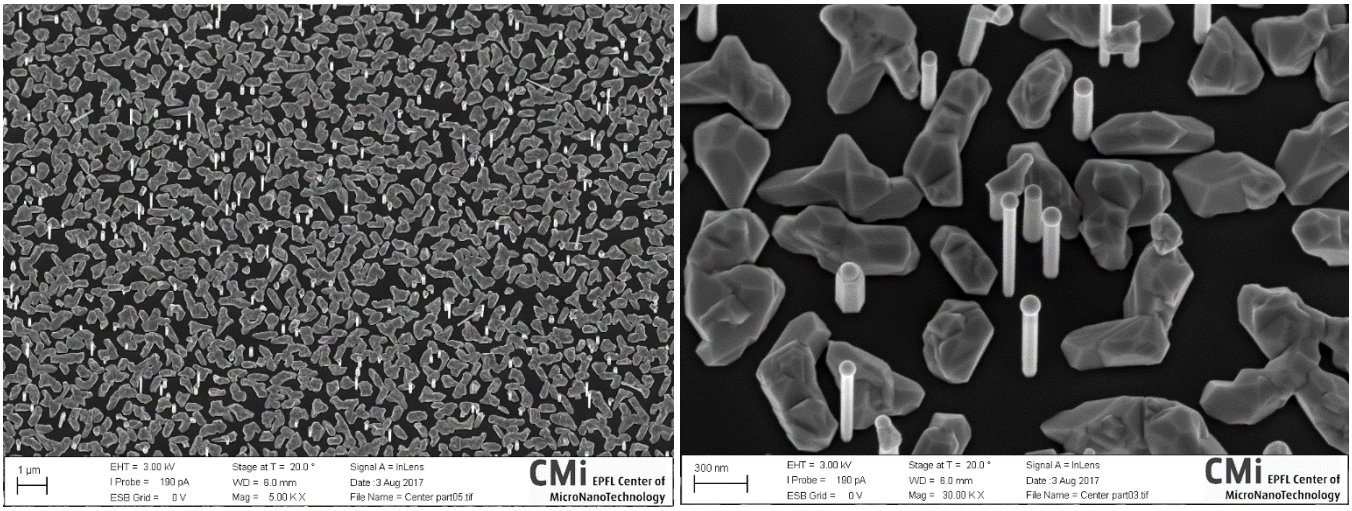

Figure S1: Growth results in 5k (left) and 30k (right) magnification, showing island-like clusters, longer nanowires (typically ZB), and shorter nanowires (typically WZ).

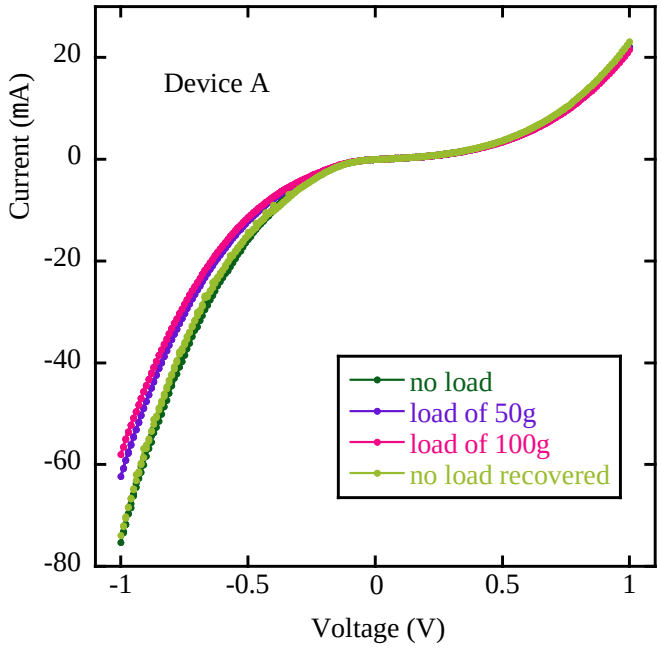

Figure S2: I-V curve for Device A under load

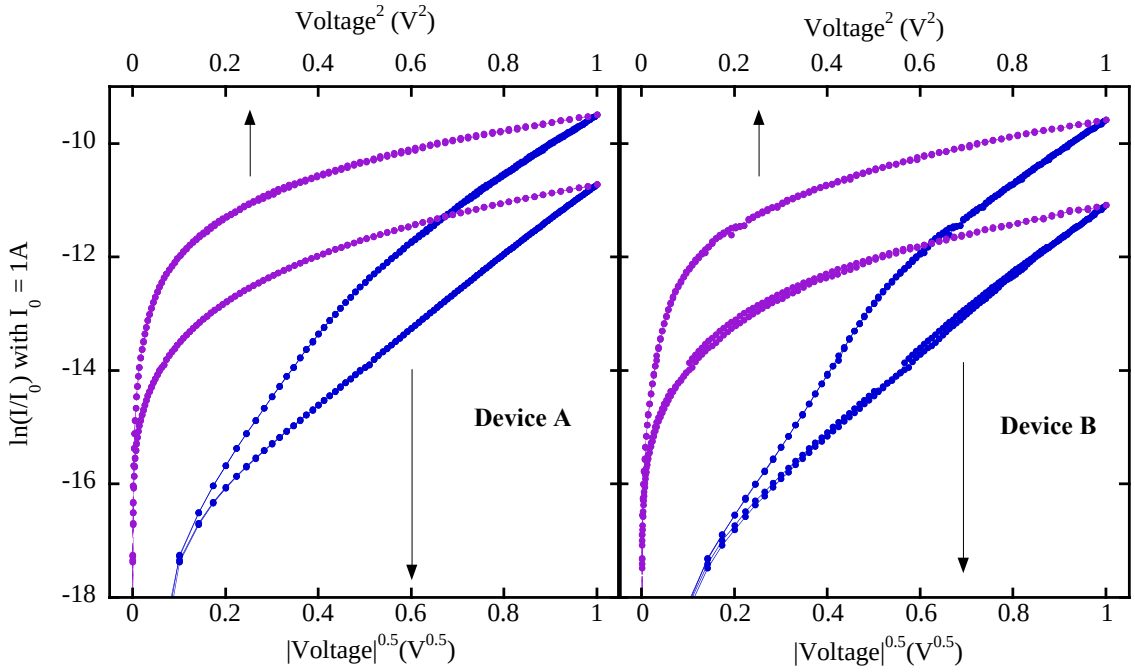

Figure S3: Comparison of $ln(I) \sim \sqrt{V}$ (blue) and $ln(I) \sim (V)^2$ (purple) for both devices and both voltage directions. The lower curves in both cases are for positive polarity. There is no voltage region for which $ln(I) \sim (V)^2$ is a good fit.

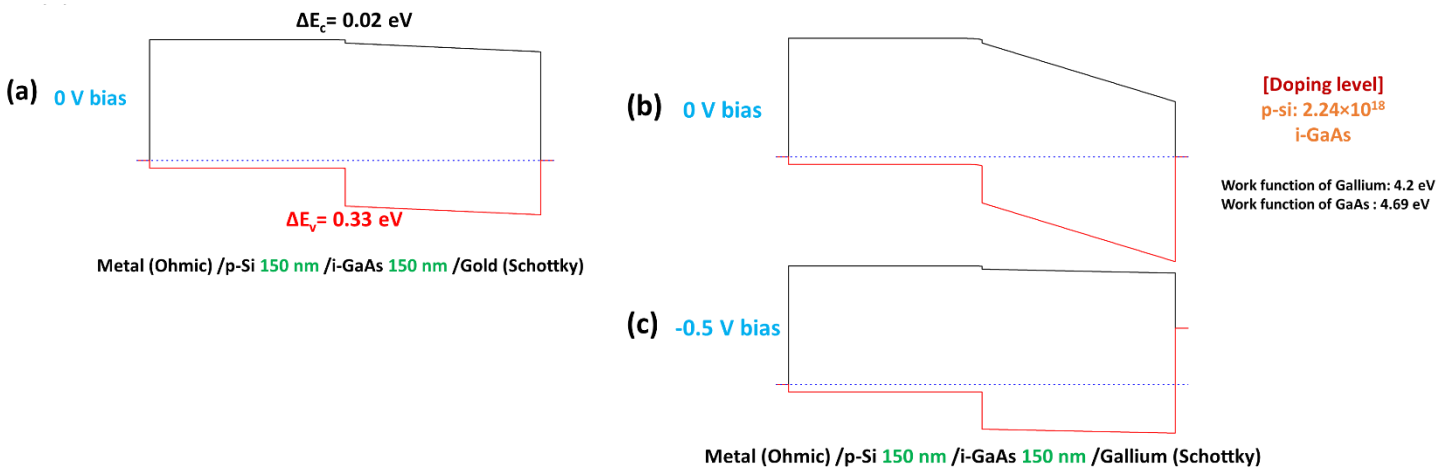

Figure S4: Band diagram simulation results obtained by Nextnano for (a) device contacted by gold, without bias; (b) device contacted by gallium, without bias; (c) same as (b) with negative bias. In the gold contact Fermi level pinning was considered, while in the gallium contact ideal Schottky barrier is considered. The values for conduction and valance band offsets are displayed on the figure.

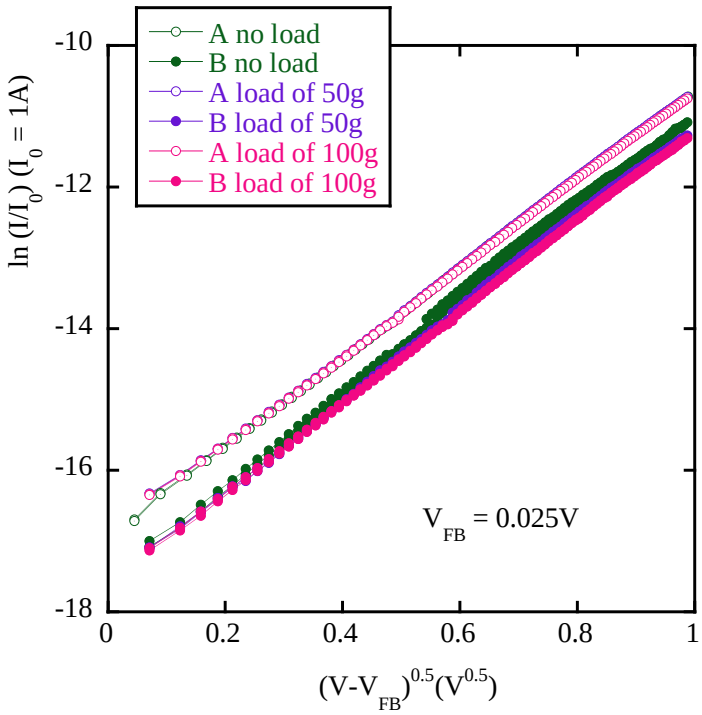

Figure S5: $ln(I) \sim \sqrt{V - V_{FB}}$ for two devices for the positive polarity of the I-V curves. The value of V_{FB} is 0.025V for both devices and does not change under applied load.

Table S6 – details and calculated pressure applied by the used weights. Bottom rows are the areas associated with the PDMS covered slip, the substrate and a single contact patch acting as a device. Indicating that the weights covered more than the sample.

Mass [g]	**d [mm]**	**area [m^2]**	**Pres. [Pa]**
50	18	0.0002545	1925.578324
100	22	0.0003801	2578.047012
PDMS		0.000625	
Sample		0.000225	
device		0.000009	

[1] Birner S, Zibold T, Andlauer T, Kubis T, Sabathil M, Trellakis A and Vogl P 2007 Nextnano: general purpose 3D simulations IEEE Trans. Electron Devices 54 2137–42